Module 01 Homework

1. Three small spherical insulators are suspended from thin thread. It is found that insulators 1 and 2 repel each other, and that insulators 2 and 3 attract each other.

    1. Consider all of the different ways this would be possible. I.e. could insulator 1 have any excess charge on it? If so, could it be positive or negative?

    2. What would happen if insulators 1 and 3 were brought together? Would they attract? Repel? Is it possible to tell?

2. Pennies used to be made out of solid copper (now they are made out of zinc with a copper plating). Imagine that you were able to remove all of the negative charges from an old, 3.1 g solid copper, penny and move them to the Moon. What would the electrostatic force between the negative charge you remove and the positive charge left on the penny be? Calculate this force in both Newton and pounds. Would you be able to keep the penny from being accelerated toward the Moon?

3. Consider the electron an proton in a Hydrogen ateom. The Bohr radius (`https://en.wikipedia.org/wiki/Bohr_radius`) is a physical constant that gives the most probable distance between the proton and electron in the atom. When the electron orbiting the protron at a distance equal to the Bohr radius, how much stronger is the electrostatic force between them than the force of gravity? Calculate the ratio of the electrostatic force over the gravitational force.

4. An initially neutral conducting sphere with radius R is charged by induction. A second, *identical*, conducting sphere that is electrically neutral is brought into contact with the first and then removed. When the two spheres are placed next to each other such that their surfaces are a distance D apart, they exert a force on each other with magnitude F. How much charge was placed on the first sphere during the induction process?

5. Two point charges, q_1 and q_2 (with $q_1 \neq q_2$), are placed a distance D apart (assume they are positive charges). A proton is then placed on the line that passes through both charges, and the net force exerted on the proton is zero. How far is the proton from q_1?

6. Four charges are fixed to the corners of a square with sides of length L (See Figure 2). Charges q_1, q_2, and q_3 each have a charge $+q$. The net force exerted on q_2 is zero, what is the charge of q_4?

7. Consider the charges pictured in Figure 1.

    1. What is the net force on the charge located at $x = 8.00\,\text{cm}$ in part (a) of the figure?

    2. What is the net force on the charge located at $x = 8.00\,\text{cm}$ in part (b) of the figure?

8. **Example Problem Write-Up:** Consider a Hydrogen atom. Treating the electron as a point mass in orbit around the proton, use classical orbital mechanics to derive a formula for the electron's orbital distance as a function of its *kinetic energy*, assuming the electron is in a circular orbit.

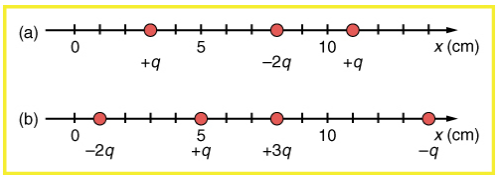

Figure 1:

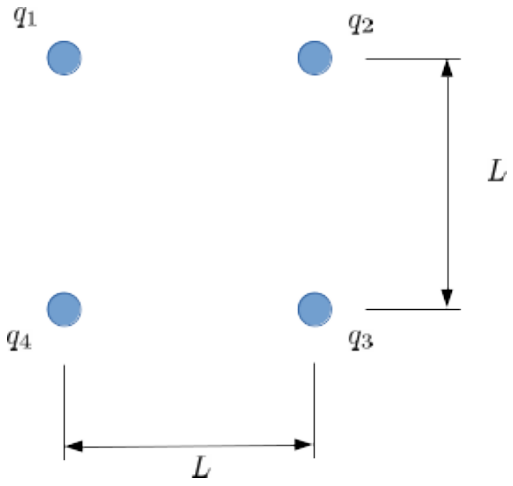

Figure 2: